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Published in:
Orthopaedic Journal of Sports Medicine

DOI:
10.1177/2325967116634075

Original Research

The Epidemiology of Injuries in Australian Professional Rugby Union 2014 Super Rugby Competition

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Background: Rugby union is a collision-based ball sport played at the professional level internationally. Rugby union has one of the highest reported incidences of injury of all team sports.

Purpose: To identify the characteristics, incidence, and severity of injuries occurring in Australian professional Super Rugby Union.

Design: Descriptive epidemiology study.

Methods: The present study was a prospective epidemiology study on a cohort of 180 professional players from 5 Australian Super Rugby teams during the 2014 Super Rugby Union Tournament. Team medical staff collected and submitted daily training and match-play injury data through a secure, web-based electronic platform. The injury data included the main anatomic location of the injury, specific anatomic structure of the injury, injury diagnosis, training or match injury occurrence, main player position, mechanism of injury, and the severity of the injury quantified based on the number of days lost from training and/or competition due to injury.

Results: The total combined incidence rate for injury during training and match-play across all Australian Super Rugby Union teams was 6.96 per 1000 hours, with a mean injury severity of 37.45 days lost from training and competition. The match-play injury incidence rate was 66.07 per 1000 hours, with a mean severity of 39.80 days lost from training and competition. No significant differences were observed between forward- and back-playing positions for match or training injury incidence rate or severity.

Conclusion: The incidence of injury for the present study was lower during match-play than has previously been reported in professional rugby union; however, the overall time loss was higher compared with previous studies in professional rugby union. The high overall time loss was due fundamentally to a high incidence of injuries with greater than 28 days' severity.

Keywords: injury surveillance; prospective; sport; incidence; severity

Rugby union is a field-based ball sport contested between 2 opposing teams of 15 players, including 8 forward-playing positions and 7 back-playing positions. The main objective of the competition is to score more points than the opposition. The offensive team is the one that possesses the ball and attempts to progress toward the defending team's goal line. The player with the ball must attack the defensive line through forcefully running at the defense line, passing between players within their team, kicking and chasing the ball, and attempting to run through gaps in the opposition's defense. The team without possession of the ball may use physical contact to tackle the opposition's player with the ball to limit advancements of the ball toward their goal area and force errors to regain possession of the ball. Dissimilar to many contact sports, rugby union players do not wear helmets or protective padding.

Rugby union is played at the professional level internationally, with the largest professional competition in the southern hemisphere being the Super Rugby Union competition, comprising 15 teams from 3 countries (Australia, South Africa, and New Zealand). Uncertainty exists regarding injury characteristics and the incidence and severity of injuries occurring within Australian professional teams

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The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The Orthopaedic Journal of Sports Medicine, 4(3), 2325967116634075
DOI: 10.1177/2325967116634075

participating in the Super Rugby Union competition. A greater understanding of the epidemiology of injury during a regular-season period of Super Rugby Union is needed to develop rugby-specific injury prevention strategies[27] and training and recovery programs to facilitate optimal on-field performance and reduce the risk of injury.

Rugby union is quantifiably a game of high physicality that involves intermittent high-intensity exercise[6] and encompasses multiple collisions resulting in repeated blunt force trauma,[15] multiple accelerations and decelerations above 7*g*,[15] and rapid changes of direction[5,15] in training and competition. As a consequence of the aforementioned characteristics, rugby union retains one of the highest injury incidences of any team sport.[29] Specifically, previous studies involving professional rugby union have identified an injury incidence of between 83.3 match-play injuries per 1000 player hours[22] and 91 match-play injuries per 1000 player hours,[3,8,10] where an injury was defined as "an injury preventing a player competing in a match or missing >1 days training."[29] Recently, an analysis in South African Super Rugby Union[22] identified >80% of all injuries involved the musculoskeletal system, namely muscle/tendon or joint/ligament injuries. In other sports, the incidence of injury has been reported to be 32.8 match injuries per 1000 hours for professional soccer,[24] 59.6 injuries per 1000 hours for professional ice hockey,[26] and 25.7 injuries per 1000 hours for Australian rules football.[17] Recent studies[2-4,22,25] have added to our understanding of the incidence of injury during professional rugby union match-play; however, there is a lack of information regarding injury characteristics as well as the incidence and severity of injuries occurring in Australian professional Super Rugby Union training and competition.

To decrease the incidence of injuries, previous studies in professional team sports[18,19,27] have recommended research follow the 4-stage van Mechelen paradigm[27] for injury prevention. The van Mechelen paradigm[27] requires the identification of common and serious injuries, identification of risk factors, institution of injury preventative programs, and monitoring the success of injury prevention programs. Previous epidemiology studies[17,18,24,26] in soccer, ice hockey, Australian rules football, and rugby union[2-4,22] have successfully identified common and serious injuries. It is necessary to build on previous studies[2-4,22] in professional rugby union for a greater ability to discern risk factors for injury. The present study will provide new information regarding the nature of injuries in Super Rugby Union training and competition that have not previously been reported at a professional level of competition. The aim of this study was to identify the nature, incidence, and severity of injuries sustained during match-play and training in professional Australian rugby union.

METHODS

Study Design

The present study was a prospective epidemiology study of a cohort of 180 professional male rugby union players.

TABLE 1
Subject Characteristics With Between-Position Comparisons[a]

Playing Position	n	Age, y	Height, cm	Body Mass, kg
Forwards	98	25.17 ± 3.38	189.26 ± 7.43	111.16 ± 7.11
Backs	82	24.46 ± 2.71[b]	184.94 ± 5.36[c]	91.43 ± 7.14[c]
Total	180	24.78 ± 3.15	186.90 ± 7.04	100.40 ± 12.03

[a]Data are presented as mean ± SD.
[b]Significant ($P < .05$) difference for backs compared with forwards.
[c]Very significant ($P < .001$) difference for backs compared with forwards. Forward-playing positions had a significantly greater age ($P < .05$), height ($P < .01$), and weight ($P < .01$) compared with back-playing positions.

Participants

Rugby union players from all 5 Australian teams competing in the Super Rugby Union competition participated in the study (N = 180). The study was a collaborative investigation between the Australian Rugby Union (ARU) and the Faculty of Health Science and Medicine of Bond University, Queensland, Australia. All 5 Australian Super Rugby Union franchises participated in the study. After agreement of the franchises to participate, the medical staff were informed of the data collection processes. Players from each rugby franchise were identified as participants for the present study. Players were provided with explanatory statements and briefed in relation to the methodology of the study by the team medical staff before providing written informed consent. The published data represent 100% participation of the players competing in the Super Rugby Union competition. Subject characteristics are presented in Table 1. The study protocol was approved by the Bond University Human Research Ethics Committee.

Competition

The present research represents player injury data from players competing in the competitive season of the 2014 Super Rugby Union competition. During the 2014 Super Rugby Union, teams played a total of 16 matches over the season excluding finals. In the 2014 Super Rugby Union competition, 2 Australian teams qualified for the finals series. A total of 84 team matches occurred over the competition. The competition season ran in 2014 from February 15 until July 12, and the grand final took place on August 2. There was a 3-week break in competition between rounds 16 and 17 for an international tournament. A total of 32 players from the Australian Super Rugby Union teams were selected and participated in the international tournament. Injuries during the international tournament were not included in this study.

Data Collection

Each injury episode during training or match-play was outlined in a detailed injury report that was completed by team

medical staff. The injury report comprised a questionnaire of the injury specifics, including injury diagnosis, mechanism of injury, nature of injury, and details of return to training and match-play. Injuries were diagnosed using the Orchard Sports Injury Classification System,[20] which is a commonly used injury classification system in Australian professional sport[9,19,20] and professional rugby union internationally.[3] Injuries were recorded using national database software used by the Australian Rugby Union franchises, allowing for uniformity of data entry processes.

All injuries were reported by medical staff contemporaneously and within 48 hours of injury diagnosis to ensure accuracy of detail when completing injury record documentation. The medical staff completing the questionnaire was required to liaise with players and training staff to accurately gain the required information. For acute match-play injuries with known match time of onset, the detail of the injury report was confirmed through video review of the injury by a single investigator independent of each franchise to ensure consistency of injury mechanisms between teams.

Injury Definitions

An *injury* was defined as "an injury preventing a player from talking full part in training or match-play for a period of greater than 24 hours from midnight at the end of the day the injury was sustained,"[9] adapted from the Rugby Injury Consensus Group established by the International Rugby Board for the standardization of injury reports within rugby union. The definition provides a practical and rugby union–specific definition for the purpose of data collation and injury surveillance rather than a theoretical definition. Based on that feedback from ARU and Super 15 medical staff, a further statement was added to the consensus statement injury definition for further clarification: "Injury (addendum): In the event a player is withdrawn from training or match-play for a short-term period as a preventative measure against injury, this should not be recorded as an injury, for example restricted training due to muscle soreness." Injury severity was reported as "the number of days that had elapsed between the day the injury was sustained until the player returns to full training and availability for match-play selection."[9] A *recurrent injury* was defined as "an injury of the same type and at the same site as an index injury and which occurs after a player's return to full participation from the index injury."[9] *Training exposure* was defined as "team-based and individual physical activities under the control or guidance of the team's coaching and fitness staff that are aimed at maintaining or improving players' rugby skills or physical conditioning."[9]

Statistical Analysis

The number of injuries are reported for the duration of the season, and injury incidence is reported per 1000 player hours. The Super Rugby Union season consisted of a total of 84 team matches for the 5 Australian franchise teams. The 84 matches involved 1680 player hours: 896 hours for forward positions and 784 hours for back positions.

Player hours were calculated as follows: 84 matches $\times$ 1.333 hours per match = 112 total match hours; 112 total match hours $\times$ 15 players = 1680 player hours; 1680 player hours $\times$ 8/15 (number of forward-playing positions/total playing positions) = 896 forward-position player hours; 1680 player hours $\times$ 7/15 (number of back-playing positions/total playing positions) = 784 back-position player hours.

Training hours were calculated as follows: Team medical staff of each Australian franchise team recorded the hours trained in each session. Training hours were multiplied by the number of players in each team to determine the training player hours. It was assumed that all players on the team completed the entire training session. Training hours included strength, conditioning, and skills training sessions.

Subject characteristics are represented with means and standard deviations. Significance was assessed for positional differences in subject characteristics using an independent-samples t test. Between-group comparisons for injury severity were assessed using an independent-samples t test or 1-way analysis of variance (ANOVA). Significance was assessed for injury proportion using a chi-square goodness-of-fit test. All statistical analyses were performed using SPSS for Windows (version 14.0; IBM Corp). The criterion level for statistical significance was set at $P < .05$. Injury incidence is expressed as rate per 1000 player hours with 95% confidence interval, and injury severity is expressed as mean number of days lost with 95% confidence interval. Injury incidence and injury severity data were entered into a spreadsheet (Microsoft Office Excel for Windows 2003; Microsoft Corp) for the subsequent calculation of confidence intervals.

RESULTS

Players in forward-playing positions had a significantly greater age ($P < .05$), height ($P < .01$), and weight ($P < .01$) compared with those in back-playing positions.

Injury Incidence

Over the 2014 Super Rugby Union season the total injury count in the Australian teams was 161 injuries sustained during training and match-play that result in >1 day lost from training or match-play. Match-play injuries accounted for 69% of the total injuries sustained and had a significantly ($P < .05$) greater incidence rate (66.07; 95% CI, 53.78-78.36) compared with the expected frequency. No significant difference was observed for injury incidence rates when separated as forward positions and back positions (Table 2).

Injury Severity

The average time lost per injury was 37.45 days (95% CI, 34.18-40.82). The total time lost due to injury for the 5 Australian Super Rugby Union teams was 6029 days.

TABLE 2
Injury Incidence Rate and Severity Between Match Play and Training[a]

	n (%)	IR (95% CI)	Severity (95% CI)
All injuries	161 (100)	6.96 (5.89-8.04)	37.45 (34.18-40.82)
Match	111 (69)	66.07 (53.78-78.36)	39.80 (35.87-43.83)
Training	50 (31)	2.33 (1.69-2.98)	32.22 (26.36-38.26)
Forwards	70 (43)	5.57 (4.27-6.87)	37.46 (32.51-42.57)
Match	50 (31)	55.80 (40.34-71.27)	38.84 (32.98-44.92)
Training	20 (12)	1.71 (0.96-2.46)	34.00 (24.74-43.64)
Backs	91 (57)	8.63 (6.85-10.40)	37.44 (33.10-42.00)
Match	61 (38)	77.81 (58.28-97.33)	40.59 (35.29-46.18)
Training	30 (19)	3.07 (1.97-4.17)	31.03 (23.47-39.03)

[a]Incidence reported per 1000 hours; severity reported as time lost in days. IR, injury incidence rate.

TABLE 3
Injury Incidence Rate and Severity for New and Recurrent Injuries[a]

	n (%)	IR (95% CI)	Severity (95% CI)
All injuries			
New	136 (84)	6.17 (5.14-7.21)	34.97 (31.42-38.52)
Recurrent	25 (16)	1.13 (0.69-1.58)	50.92 (42.63-59.21)
Forwards			
New	58 (36)	4.62 (3.43-5.80)	31.91 (26.47-37.35)
Recurrent	12 (7)	0.95 (0.41-1.50)	64.25 (52.29-76.21)
Backs			
New	78 (48)	7.39 (5.75-9.03)	37.24 (32.55-41.93)
Recurrent	13 (8)	1.23 (0.56-1.90)	38.62 (27.13-50.10)

[a]Incidence reported per 1000 hours; severity reported as time lost in days. IR, injury incidence rate.

The time lost due to match-play injures was 4418 days, equivalent to 52.60 days lost per club per match. No significant difference in injury severity was found between match-play injuries and training injuries or for injury severity between forward- and back-playing positions (Table 2).

New and Recurrent Injuries

Of the 161 time-loss injuries, 136 were new injuries and 25 were recurrent injuries (Table 3). No significant difference in injury severity was observed for recurrent injuries (50.92; 95% CI, 42.63-59.21) or new injuries (34.97; 95% CI, 31.42-38.52) compared with the expected frequency. When comparing forward and back positions, no significant difference was observed between injury incidence rates for new or recurrent injuries. Recurrent injury severity for forward positions was not significantly different (64.25; 95% CI, 52.29-76.21) from that for back positions (38.62; 95% CI, 27.13-50.10), as presented in Table 3.

Injury Incidence Distribution by Severity

Figure 1 displays the injury incidence (per 1000 hours) as a product of injury severity. A similar trend is observed between forward and back positions for minor (0-7 days lost) and moderate (7-28 days lost) injuries. For injuries with more than 60 days time lost, back positions had an injury incidence of 23 injuries per 1000 hours compared with forward positions with an injury incidence of 10 per 1000 hours.

Anatomic Locations of All Injuries

Lower limb injuries were the main anatomic location injured, with a significantly greater injury incidence compared with the expected incidence rate ($P < .001$) (Table 4). The high incidence of lower limb injuries was largely the result of knee (incidence, 1.2) and thigh (incidence, 1) injuries. Tables 5 and 6 compare injury data between matches and training. There was a disproportionately higher percent of head and upper limb injuries in match-play compared with training injuries. Training injuries are presented in Table 6 and were weighted more toward lower limb injuries, in particular, thigh injuries. The mean severity of knee injuries (86.54; 95% CI, 78.25-94.83) was greater than all other main anatomic locations. Severity of knee injuries remained the most severe when separated into training (125.29; 95% CI, 109.31-141.27) and match-play (72.26; 95% CI, 62.56-81.96) injuries. Other severe match-play injuries included ankle injuries, lower leg (tibia/fibula) injuries, and shoulder/clavicle injuries. Severe training injuries included hip/groin injuries and hand/wrist/finger injuries. The anatomic regions mentioned in Table 5 had greater injury incidence rates in match-play injuries compared with training injuries (Table 6), excluding injuries to neck/cervical, upper arm/forearm/elbow, hand/finger/wrist, lower back/lumbar, pelvis/sacrum/abdomen, foot/toe, and lower leg regions. Head and neck injuries were associated with the shortest time loss due to injury while upper limb and lower limb injuries were associated with the greatest time loss due to injury. Head/face was the most frequently injured specific anatomic region, largely as a result of concussion (see Table 4).

Table 7 displays match-play injuries separated by main anatomic location and tissue type. Joint and ligament injuries were the most frequently injured tissue type (54.5 injuries/1000 hours) followed by muscle/tendon injuries (43.8 injuries/1000 hours). There was a greater injury incidence of muscle/tendon injuries in back positions (29.3 injuries/1000 hours) compared with forward positions (14.5 injuries/1000 hours); however, the mean injury severity was greater for muscle/tendon injuries for forwards (29.8 days) compared with backs (19.3 days).

Most Severe Injuries

Anterior cruciate ligament (ACL) injuries resulted in the greatest time lost due to injury for the forward positions,

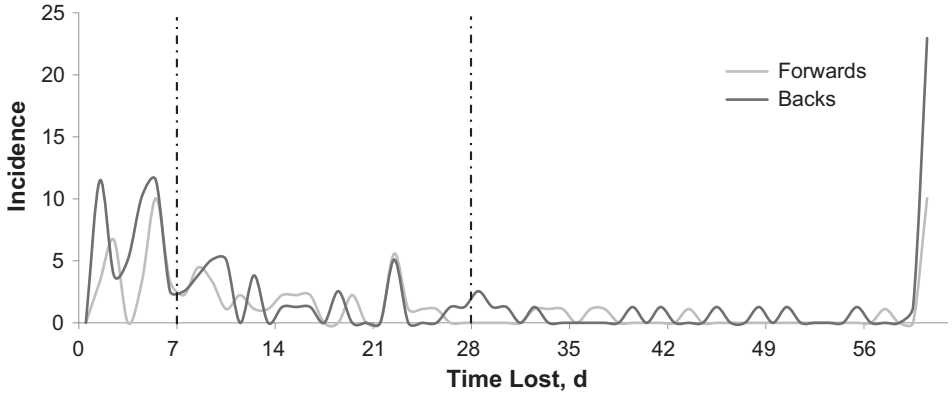

Figure 1. Injury incidence (per 1000 hours) as a function of injury severity (time lost in days). The dotted lines represent injury severity groups based on the consensus statement for injury definitions in rugby union.[9] Injury severity groups are classified as mild/minimal (less than or equal to 7 days), moderate (8-28 days), or severe (greater than 28 days).

TABLE 4
Incidence and Severity of All Injuries Distributed by Anatomic Location[a]

Main Anatomic Location	n (%)	IR (95% CI)	Severity (95% CI)
Head/neck			
All head/neck injuries	33 (20.5)	1.5 (0.99-2.01)	14.21 (6.85-21.57)
Head/face	27 (16.8)	1.2 (0.76-1.69)	16.26 (8.12-24.40)
Neck/cervical spine	6 (3.7)	0.3 (0.05-0.49)	5.00 (0-22.26)
Upper limb			
All upper limb injuries	21 (13.0)	1 (0.55-1.36)	49.90 (40.68-59.13)
Shoulder/clavicle	15 (9.3)	0.7 (0.34-1.03)	59.73 (48.82-70.65)
Upper arm/forearm/elbow	2 (1.2)	0.1 (0-0.22)	42.50 (12.61-72.39)
Hand/finger/wrist	4 (2.5)	0.2 (0.00-0.36)	16.75 (0-37.89)
Trunk			
All trunk injuries	15 (9.3)	0.7 (0.34-1.03)	17.80 (6.88-28.72)
Upper trunk/chest/thorax/rib	8 (5.0)	0.4 (0.11-0.61)	20.38 (5.43-35.32)
Lower back/lumbar	4 (2.5)	0.2 (0.00-0.36)	16.25 (0-37.39)
Pelvis/sacrum/abdomen	3 (1.9)	0.1 (0-0.29)	13.00 (0-37.41)
Lower limb			
All lower limb injuries	92 (57.1)	4.2 (3.32-5.03)	46.14 (41.73-50.55)
Hip/groin	13 (8.1)	0.6 (0.27-0.91)	27.23 (15.51-38.96)
Thigh	23 (14.3)	1 (0.62-1.47)	15.30 (6.49-24.12)
Knee	26 (16.1)	1.2 (0.73-1.63)	86.54 (78.25-94.83)
Ankle	15 (9.3)	0.7 (0.34-1.03)	49.80 (38.88-60.72)
Foot/toe	8 (5.0)	0.4 (0.11-0.61)	20.38 (5.43-35.32)
Lower leg	7 (4.3)	0.3 (0.08-0.55)	54.14 (38.16-70.12)

[a]Incidence reported per 1000 hours; severity reported as time lost in days. IR, injury incidence rate.

largely due to the severity of ACL injuries rather that the injury count (Table 8). Shoulder dislocation/instability injuries were the soft tissue injury associated with greatest time loss. The largest time lost due to injury in back positions was the result of lower limb fracture/dislocation.

Match-Play Event Associated With Injury

Being tackled was the event most associated with injury in match-play (Table 9). The 3 main events associated with injury were contact events including being tackled (22.5%), tackling (20.7%), and collision (19.8%). All contact events accounted for 75.7% of the total injury count, while noncontact events accounted for 9% of the total injury incidence (15.3% unknown). Noncontact injuries accounted for 16.4% of the total time loss due to injury in match-play compared with noncontact injuries, which accounted for 70.45% of the total time lost.

DISCUSSION

The main findings of this study include the following: (1) On average, each Australian Super Rugby Union club will have 32 injuries requiring time away from training or match-play of an average severity of 37.4 days. (2) Based on the average injury severity and injury incidence rate, a

TABLE 5
Incidence and Severity of Match Injuries Distributed by Anatomic Location[a]

Main Anatomic Location	n (%)	IR (95% CI)	Severity (95% CI)
Head/neck			
All head/neck injuries	25 (22.5)	14.9 (9.05- 20.71)	14.52 (6.06-22.98)
Head/face	22 (19.8)	13.1 (7.62-18.57)	15.64 (6.62-24.65)
Neck/cervical spine	3 (2.7)	1.8 (0-3.81)	6.33 (0-30.74)
Upper limb			
All upper limb injuries	19 (17.1)	11.3 (6.22-16.39)	52.84 (43.14-62.54)
Shoulder/clavicle	15 (13.5)	8.9 (4.41-13.45)	59.73 (48.82-70.65)
Upper arm/forearm/elbow	2 (1.8)	1.2 (0-2.84)	42.5 (12.61-72.39)
Hand/finger/wrist	2 (1.8)	1.2 (0-2.84)	11.5 (0-41.39)
Trunk			
All trunk injuries	9 (8.1)	5.4 (1.86-8.86)	22.22 (8.13-36.31)
Upper trunk/chest/thorax/rib	6 (5.4)	3.6 (0.71-6.43)	23.33 (6.07-40.59)
Lower back/lumbar	1 (0.9)	0.6 (0-1.76)	23 (0-65.28)
Pelvis/sacrum/abdomen	2 (1.8)	1.2 (0-2.84)	18.5 (0-48.39)
Lower limb			
All lower limb injuries	58 (52.3)	34.5 (25.64-43.41)	49.16 (43.6-54.71)
Hip/groin	8 (7.2)	4.8 (1.46-8.06)	26.75 (11.8-41.7)
Thigh	14 (12.6)	8.3 (3.97-12.7)	14.71 (3.42-26.01)
Knee	19 (17.1)	11.3 (6.22-16.39)	72.26 (62.56-81.96)
Ankle	9 (8.1)	5.4 (1.86-8.86)	65 (50.91-79.09)
Foot/toe	3 (2.7)	1.8 (0-3.81)	44 (19.59-68.41)
Lower leg	5 (4.5)	3 (0.37-5.58)	68.2 (49.29-87.11)

[a]Incidence reported per 1000 hours; severity reported as time lost in days. IR, injury incidence rate.

TABLE 6
Incidence and Severity of Training Injuries Distributed by Anatomic Location[a]

Main Anatomic Location	n (%)	IR (95% CI)	Severity (95% CI)
Head/neck			
All head/neck injuries	8 (16.0)	0.4 (0.12-0.67)	13.25 (0-28.2)
Head/face	5 (10.0)	0.2 (0.03-0.46)	19 (0.09-37.91)
Neck/cervical spine	3 (6.0)	0.1 (0-0.31)	3.67 (0-28.08)
Upper limb			
All upper limb injuries	2 (4.0)	0.1 (0-0.23)	22 (0-51.89)
Shoulder/clavicle	0 (0.0)	0 (0-0)	
Upper arm/forearm/elbow	0 (0.0)	0 (0-0)	
Hand/finger/wrist	2 (4.0)	0.1 (0-0.23)	22 (0-51.89)
Trunk			
All trunk injuries	6 (12.0)	0.3 (0.06-0.53)	11.17 (0-28.43)
Upper trunk/chest/thorax/rib	2 (4.0)	0.1 (0-0.23)	11.5 (0-41.39)
Lower back/lumbar	3 (6.0)	0.1 (0-0.31)	14 (0-38.41)
Pelvis/sacrum/abdomen	1 (2.0)	0 (0-0.15)	2 (0-44.28)
Lower limb			
All lower limb injuries	34 (68.0)	1.7 (1.11-2.23)	41 (33.75-48.25)
Hip/groin	5 (10.0)	0.2 (0.03-0.46)	28 (9.09-46.91)
Thigh	9 (18.0)	0.4 (0.15-0.73)	16.22 (2.13-30.31)
Knee	7 (14.0)	0.3 (0.09-0.6)	125.29 (109.31-141.27)
Ankle	6 (12.0)	0.3 (0.06-0.53)	27 (9.74-44.26)
Foot/toe	5 (10.0)	0.2 (0.03-0.46)	6.2 (0-25.11)
Lower leg	2 (4.0)	0.1 (0-0.23)	19 (0-48.89)

[a]Incidence reported per 1000 hours; severity reported as time lost in days. IR, injury incidence rate.

team may expect to have between 7 to 8 players unavailable to play as a consequence of match-play injuries after 6 consecutive rounds without a bye in Super Rugby Union. Additionally, with approximately 1 player injury every 19 days during training with an average severity of 32.2 day, 8 to 9 players may be expected to be unavailable at a single point due to training and match-play injuries. (3) The most frequent injury sustained was a concussion, which may be expected to occur on average once every 4 to 5 matches per team.

TABLE 7
Match-Play Injury Incidence and Mean Severity by Anatomic Location and Tissue Type[a]

		Head/Neck		Upper Limb		Trunk		Lower Limb		All	
Tissue Type	Position	IR	Severity	IR	Severity	IR	Severity	IR	Severity	IR	Severity
Muscle/tendon	Forwards	—	—	2.2	107.5	2.2	18.5	10.0	15.0	14.5	29.8
	Backs	1.3	9.0	1.3	13.0	2.6	51.0	24.2	16.8	29.3	19.3
Joint/ligament	Forwards	2.2	5.0	7.8	44.7	2.2	23.0	16.7	72.5	29.0	56.0
	Backs	1.3	29.0	8.9	52.4	—	—	15.3	80.2	25.5	67.9
CNS/brain	Forwards	8.9	7.8	—	—	—	—	—	—	8.9	7.8
	Backs	11.5	7.2	—	—	—	—	—	—	11.5	7.2
Bone	Forwards	—	—	—	—	2.2	6.5	—	—	2.2	6.5
	Backs	5.1	47.0	1.3	72.0	1.3	2.0	3.8	115.3	11.5	67.6
Neurological	Forwards	—	—	1.1	24.0	—	—	—	—	1.1	24.0
	Backs	—	—	—	—	—	—	—	—	—	—
All	Forwards	11.2	7.2	11.2	55.2	6.7	16.0	26.8	50.9	55.8	38.8
	Backs	19.1	19.4	11.5	50.2	3.8	34.7	43.4	47.9	77.8	40.6
	All	15.5	14.5	11.3	52.8	5.4	22.2	34.5	49.2	66.1	39.8

[a]Incidence reported per 1000 hours; severity reported as time lost in days. CNS, central nervous system; IR, injury incidence rate.

TABLE 8
Injuries Associated With the Greatest Time Loss

Position and Injury	Total Days Absent	Days Absent/ 1000 Hours
Forwards		
Anterior cruciate ligament	568	634
Shoulder dislocation/instability	290	324
Lower limb fracture/dislocations	227	253
Rotator cuff injury	210	234
Medial collateral ligament	167	186
Ankle sprain	76	85
Concussion	62	69
Backs		
Lower limb fracture/dislocations	471	601
Shoulder dislocation/instability	367	468
Posterior cruciate ligament	236	301
Facial/jaw fractures	188	240
Ankle sprain	161	205
Ankle osteochondral/joint injury	116	148
Hamstring strain	109	139

Incidence and Severity of Match-Play and Training Injuries

The injury incidence rate for the present study was lesser during match-play[2,3,22] and greater during training[4,22] than has previously been reported in professional rugby union. Specifically, the present study identified a match-play injury incidence rate of 66.07 injuries per 1000 hours and a training injury incidence rate of 2.33 injuries per 1000 hours. In the 2012 Super Rugby Union competition, a study[22] of the 5 South African teams identified an injury incidence rate of 83.3 injuries per 1000 hours for match-play and 2.1 injuries per 1000 hours for training. A study[3] of English Premiership rugby reported an injury incidence rate of 91 injuries per 1000 hours during match-play. The mean match-play injury severity for the present study was 39.8 days. Brooks and colleagues[3] reported a mean injury severity of 18 days in English Premiership rugby. In the present study, injuries with >28 days severity accounted for 41.4% of the total injury incidence, while in South African Super Rugby Union, they accounted for 14.8% of the total injury incidence.[22] Although the injury incidence rate in the present study was considerably below the injury incidence rates reported by Schwellnus et al[22] and Brooks et al,[3] due to the high injury severity, the total time lost per 1000 hours match-play was 2630 days for the present study compared with 1638 days lost per 1000 hours in English Premiership rugby.[3] The present study used the same injury definitions[9] as used by Schwellnus et al[22] and Brooks et al[3]; therefore, difference in injury rates and severities cannot be attributed to differences in recording methodologies. It is often reported that nonprofessional clubs without designated club medical staff underreport injury rates as injuries will often go untreated. The studies by Schwellnus et al[22] and Brooks et al[3] were in professional clubs; therefore, it is unlikely that injuries would go unnoticed given the requirements of player availability for performance and player welfare.

An annual report[21] for England professional rugby union identified a lower injury incidence rate for the England senior team compared with the teams competing in the premiership competition (incidence, 62 per 1000 player hours vs 82 per 1000 hours, respectively). Additionally the English senior side has shown a trending decrease in the incidence of injury over the previous 9 years while injury severity has trended toward an increase.[21] The lower incidence of injury in the English senior side compared with English Premiership rugby[21] may be due to differences in conditioning levels. In 2 studies investigating the movement characteristics in English Premiership rugby[5] and Australian Super Rugby Union,[15] the total distance covered was greater in English Premiership rugby (forwards, 5850 m; backs, 6545 m) compared with Australian Super Rugby Union (forwards, 4709 m; backs,

TABLE 9
Match-Play Events Associated With Injury[a]

Event Associated With Injury	n (%)	IR (95% CI)	Severity (95% CI)
Being tackled	25 (22.5)	14.88 (9.05 to 20.71)	53.84 (45.55 to 61.90)
Tackling	23 (20.7)	13.69 (8.10 to 19.29)	27.09 (18.45 to 35.27)
Collision	22 (19.8)	13.10 (7.62 to 18.57)	17.59 (8.76 to 26.01)
Unknown	17 (15.3)	10.12 (5.31 to 14.93)	34.24 (24.19 to 44.04)
Ruck	6 (5.4)	3.57 (0.71 to 6.43)	68.67 (51.75 to 84.85)
Running	5 (4.5)	2.98 (0.37 to 5.58)	44.20 (25.67 to 61.81)
Other noncontact	5 (4.5)	2.98 (0.37 to 5.58)	101.00 (82.47 to 118.88)
Other contact	4 (3.6)	2.38 (0.05 to 4.71)	20.50 (–0.21 to 40.56)
Scrum	3 (2.7)	1.79 (–0.24 to 3.81)	85.00 (61.08 to 107.87)
Lineout	1 (0.9)	0.60 (–0.57 to 1.76)	5.00 (–36.43 to 44.83)
Maul	0 (0.0)	—	—

[a]IR, injury incidence rate.

6005 m). However, indirect comparisons between high-speed meters show that forward positions in English Premiership rugby covered 37 m above 81% of maximum velocity while forward positions in Australian super rugby union covered 131 m above 76% of maximum velocity, including 38 m above 91% of maximum velocity, suggesting a greater amount of high-intensity activity performed in Australian Super Rugby Union compared with English Premiership rugby union. Additionally, the greater injury severity in Australian Super Rugby Union compared with English Premiership rugby may be a result of more conservative management of injuries.

New and Recurrent Injuries

In the present study, recurrent injuries accounted for 16% of the total injury incidence. Similar findings were reported for recurrent injuries in rugby union at 18%[3] and 15%[25] of the total injury incidence. Injury severity of recurrent injuries (50.92; 95% CI, 42.63-59.21) were not significantly more severe than injury severity for new injuries (34.97; 95% CI, 31.42-38.52) due to the low volume of recurrent injuries and large standard deviation about the mean. The severity of recurrent injuries reported in the present study was considerable greater than has previously been reported in rugby union[3] (50.92 compared with 27 days). The Australian Football League (AFL) reported a recurrent injury rate of 9% in 2012, which has consistently decreased since 1992 when recurrent injuries accounted for 25%.[18] The AFL partially attributes the decreasing rate of injury recurrence to significant decreases in lower limb soft tissue injuries.[18] The risk of recurrent soft tissue injuries may be mitigated with appropriate rehabilitation protocols[16] and conservative management,[18] which accounts for the modifiable factors associated with reinjury. Modifiable risk factors for recurrent injuries include decreased flexibility,[14,30] decreased eccentric strength,[14] altered lower limb biomechanics,[28] and altered muscle tissue lengthening mechanics.[23] Although these modifiable factors may influence the risk of recurrent injury, they were not recorded in the present study. Further research is needed in this area to investigate the recurrent injury rates for soft tissue injuries when controlling for modifiable risk factors.

Anatomic Location of Injury

In the present study, lower limb injuries accounted for 57% of the total injury incidence, with a mean severity of 46.14 days; in South African Super Rugby Union,[22] lower limb injuries accounted for 48.1% of the total injury proportion. When investigating the incidence rates, South African Super Rugby Union[22] had similar injury incidence rates for lower limb injuries for match-play injuries (34.4) compared with the present study (34.5) and for match-play and training injuries combined (4.4) compared with the present study (4.2). The present study had fewer upper limb injuries (incidence, 1.00; 95% CI, 0.55-1.36) compared with the South African Super Rugby Union[22] (incidence, 2.4; 95% CI, 1.7-3.2). The lower proportion of upper limb injuries was largely the result of fewer shoulder/clavicle injuries during match play. Headey et al[13] reported that professional rugby union players aged 31 to 34 years and players aged 19 to 22 years had the greatest incidence of shoulder injury compared with other players. Furthermore, professional English Premiership rugby union players with a body mass index >30.9 kg/m^2 experienced a greater incidence of more severe shoulder injuries while players 197 to 204 cm in height experienced the lowest incidence and severity of shoulder injuries.[13] The height, weight, and age of players in the present study were similar to those reported in the South African Super Rugby Union study; therefore, these variables were unlikely to account for the differences in injury incidence rates of the upper limb between the present study and those observed in South African Super Rugby Union.

Harder ground conditions have been associated with a greater number of shoulder injuries due to the direct impact between the shoulder and ground, which is common during a tackle event. Differences in ground conditions may have contributed to the observed difference in the incidence of shoulder dislocation/instability injuries between South African Super Rugby Union and Australian Super Rugby Union.

Concussion was the most frequent injury overall. The most frequent event associated with concussion was tackling, such as the head colliding with the hip of the opponent. High-speed tacking occurs more frequently in open gameplay and may have contributed to the greater incidence of concussion in back-playing positions compared with forward-playing positions (see Table 7). Rule changes were recently introduced by the International Rugby Board to better identify concussion and reduce the incidence of additional head injury while players are in a state of postconcussive vulnerability. Specifically, the decision to remove a player after a suspected concussion can be made by the referee, independent match day doctor, or the player's team doctor. Additionally, a more enhanced head injury assessment was introduced through strengthening the previously used memory test and balance test, thereby allowing for improved identification of concussion.

Most Severe Injuries

In the present study, ACL injuries (combined grades 1, 2, and 3 sprains) resulted in the greatest time lost due to injury for forward positions. A study of English Premiership rugby[3] identified a similar finding, with ACL injuries accounting for the greatest time loss due to injury for forward positions. In the back-playing positions, lower limb fracture/dislocations resulted in the greatest time lost for the present study. Previous research[3] in professional rugby union reported hamstring injury to account for the greatest time loss due to injury for back positions. Additionally, previous studies in elite soccer[1] and AFL[18] have identified hamstring injuries as having the greatest injury incidence and resulting in the greatest time away from training and match-play. In the present study, hamstring injuries were one of the injuries with the highest injury count (n = 12); however, due to the mean severity (22.9 days), hamstring injuries did not account for the greatest time loss in either forward or back positions. Shoulder dislocation/instability was in the top 3 injury types resulting in time loss due to injury for forward- and back-playing positions in the present study, which agrees with the finding in English Premiership rugby.[3]

Event Associated With Injury

Being tackled and tackling were the match-play events most associated with injury in the present study. Tackling was associated with a large portion of head injuries. Specifically, more than one-third of injuries while tackling were concussion. Being tackled was associated with a high proportion of knee ligament injuries and shoulder dislocation/instability injuries. Previous studies in rugby union[3] and rugby league[11,12] have identified the tackle as the event most associated with injury. The high incidence of tackle injuries is likely due to the high frequency of tackle events compared with other contact events[7] and the velocity of impacts, dynamic nature of change of direction, and rotational torque about joints experienced during the tackle. Collision events were the third most common event associated with injury; however, as collisions reportedly occur less frequently than tackling events, collisions have previously been reported to have the highest injury rates per 1000 collision events.[7] Noncontact injuries accounted for 9% of the total injury incidence and 16.4% of the total time loss due to injury. Specifically, injuries while running accounting for 4.5% of the total incidence in the present study. These results contrast that of Schwellnus et al,[22] who reported an 11.3% incidence of running injuries in South African Super Rugby Union.

CONCLUSION

The present study highlights the burden associated with injury in professional rugby union with a mean 32 injuries per team per season resulting in 37.4 days absent per injury. The present findings identified a greater time loss due to injury compared with previous studies that investigated professional rugby union due to a fundamentally high incidence of injuries with greater than 28 days severity. Match-play tackles and collisions are identified as the largest contributors to musculoskeletal injury rates that substantiate the unpredictability and dynamic nature of professional rugby union competition.

A detailed comparison of between-injury types with the inclusion of injury severity had not been reported for Australian professional rugby union. This study describes the injury characteristics, incidence, and severity in greater detail than has previously been reported in Australian professional rugby union. These results increase our understanding of the characteristics, incidence, and severity of injuries occurring during Australian professional rugby union training and competition.

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